The new era in helioseismology

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The end of the millennium marks the beginning of the third phase of helioseismology. The first phase was the establishment of the initial astronomical inferences, such as estimates of the depth of the solar convection zone and the protosolar helium abundance obtained by comparing the seismic properties of theoretical solar models with the first wave of helioseismic data acquired using instruments that had not been designed for the purpose. The second phase was the determination of the spherically symmetric component of the hydrostatic stratification throughout most of the solar interior, and the angular velocity, using inverse methods to analyse the frequencies of normal modes estimated from data obtained most recently from purpose-built networks of ground-based observatories and from space. We have reached the point beyond which further pursuit of the now-well-tried methods to improve the inferences will be apparently slow. The next era will be characterized by painstaking attention to detail, to extract a new level of precision necessary to isolate subtle properties of the Sun for asking more sophisticated questions. We are already seeing the normal-mode representation of helioseismic waves being complemented by other representations that may be more suitable for investigating inhomogeneity and time variability particularly of the Sun's surface layers. The outcome will enable us to address more accurately issues concerning global dynamics, the equation of state and the chemical composition, and also the properties of convection and the seat of solar activity.